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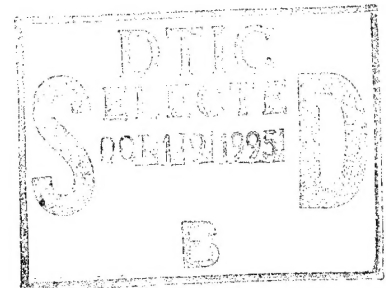
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## **INTRODUCTION**

This is the final report of this contract, with a contract period extending from 1 December 1989 to 31 March 1995. A mid-term report was submitted on 30 June, 1991, which provided a detailed analysis of the study findings during the 1989-90 influenza season, and provided only a few highlights of the 1990-91 influenza season. This report, therefore, will provide detailed information on study findings for the 1990-91 season, as well as the three remaining years of the contract, 1991-92, 1992-93, and 1993-94.

It should be noted that this is the final report in a series of studies of influenza and other respiratory diseases that have been in continuous existence at Lowry Air Force Base since 1952, supported by the U. S. Army Research and Development Command. Information gained from these studies has been extraordinarily valuable in determining the etiology of febrile respiratory disease in Air Force personnel, in assessing the continuing antigenic shift and drift of influenza viruses, in identifying candidate virus strains for subsequent formulations of influenza vaccine, and in evaluating vaccine efficacy.

Lowry Air Force Base closed during summer of 1994, and all operations there ceased as of 30 September, 1994. A manuscript for publication in the medical literature is anticipated as a result of these 42 years of study, which will highlight the scientific contributions made to our understanding of the control of influenza and other respiratory diseases.

In this report, the results of studies during the 4 years outlined above will be presented in sequence.

### **1990-91 SEASON**

The 1990-91 influenza season was characterized by an outbreak of influenza B of moderate severity that occurred in January and February, 1991, followed by a spring outbreak of influenza A/H3N2 that occurred in April. The influenza B outbreak was reflected in the surveillance at Lowry Air Force Base, but the late spring outbreak of influenza A/H3N2 was seen only in scattered locations throughout the region, notably at the Air Force Academy located just outside Colorado Springs, and in the civilian community in Brighton, Colorado, located near Denver. Only one case of influenza A was seen at Lowry Air Force Base during the 1990-91 season.



## **Response to Vaccination**

The influenza vaccine formulated for the 1990-91 season contained 15 mcg. each of A/Shanghai/16/89 (H3N2), A/Taiwan/1/86 (H1N1), and B/Yamagata/16/88. Pre- and post- vaccine serum hemagglutination inhibition (HI) antibody titers in 87 Air Force recruits, immunized at Lackland Air Force Base, are shown in Table 1, and comparable data for 28 permanent party members at Lowry Air Force Base are shown in Table 2.

Among recruits (Table 1), vaccine response was uniformly good. Pre-vaccine HI titers were quite low, as has been the usual finding in these studies. Response to the A/H3N2 and A/H1N1 antigens was quite brisk, with about 80% of the recruits having a  $\geq 4$ -fold increase in HI antibody titers. Well over 80% of the recruits achieved a post-vaccine HI titer of 1:  $\geq 64$ , a level that has previously been associated with a high degree of protection against infection by closely related strains of influenza virus.

The response to the influenza B component was surprisingly good, and was comparable to or slightly exceeded the response to the 2 influenza A antigens. This brisk response to the B antigen had been noted during the previous season, using the same antigen and as noted then, was in sharp contrast to earlier experience with influenza B antigens. Eighty-five per cent of recruits developed an antibody titer of 1:  $\geq 64$ , and 91% achieved a  $\geq 4$ -fold antibody rise.

In contrast to the recruits, the older and more frequently vaccinated permanent party personnel experienced only quite modest antibody responses. Baseline HI antibody titers were higher, than in the recruits, likely a result of prior experience with influenza viruses, either through prior vaccinations or previous infection. Post-vaccination titers, however, were substantially lower than in the recruit population, and only about half or less of the permanent party developed HI antibody titers of 1:  $\geq 64$ .

The more muted response to influenza vaccine among permanent party members, as compared to recruits, has been consistently noted in previous studies, and has never been fully explained. The net effect, however, is that permanent party members are less well protected against influenza, however. As will be noted subsequently, permanent party personnel experienced more influenza during the 1990-91 season than did recruits.

## **Occurrence of Febrile Upper Respiratory Infections**

Surveillance of febrile respiratory disease on the base was maintained from October 1990 through the end of May 1991. Individuals with febrile respiratory

infection (oral temperature of  $\geq 99.6$  F.) were asked to report to the influenza study coordinator, who described details of the study, including drawing acute and convalescent serum specimens and obtaining throat washings for virus isolation. If informed consent was given, those specimens were obtained. The level of participation was always quite high. The number of clinic visits, the number with respiratory disease, and the number of those with febrile respiratory disease is shown on a weekly basis in Table 3. Inspection of that table shows that there was no brisk increase in the number of patients seen during the year, save, perhaps, for a very modest increase during the months of January, February and March 1991.

The number of cases of influenza identified during the surveillance period is shown in Table 4. Virtually all of the cases were influenza B, and only one case of influenza A was detected on base during the entire season. A total of 21 cases of influenza B were identified, all but 2 of which occurred in personnel who had received influenza vaccine during the fall of 1990. The cases occurred during the months of January, February and March 1991; four of the cases occurred in students, and the remaining 17 cases in permanent party personnel.

Accurate figures for the number of students and permanent party personnel on base are not available, and thus we are unable to estimate attack rates. In previous years the number of students has been somewhat less than the number of permanent party, but not sufficiently less to explain the small number of cases among students. Thus, it is highly likely that the attack rate of influenza B was higher in the permanent party than in students. We believe the most likely reason for this differential in the attack rate is the better immune response to the vaccine in the students.

### **Spring Outbreak of Influenza A/H3N2 in Colorado**

In the late spring of 1991, outbreaks of influenza occurred at the United States Air Force Academy, located near Colorado Springs, and in Brighton, a small community outside Denver. Although no formal epidemiologic study was undertaken, information received from Brooks Air Force Base indicated that during the March-April 1991 school period at the Academy, approximately 25% of cadets were infected, and that all classes were affected by the epidemic. Influenza A/H3N2 was isolated from cadet specimens at the EPI laboratory of Brooks Air Force Base, Texas, and subsequently sent to the Centers for Disease Control for typing and analysis.

Two of the typed isolates were sent from Brooks Air Force Base to the influenza laboratory at the University of Colorado Health Sciences Center, together with twenty sets of paired acute and convalescent sera from Air Force Academy

cadets who experienced an influenza-like illness during the outbreak. The typed virus strains were used to prepare an antigen for evaluating sera from the outbreak. The results are presented in Table 5. A/Colorado/1/91 was isolated from a 17-year old male civilian in Brighton, Colorado, and A/Colorado/443/91 was isolated from the Air Force Academy. The two Colorado isolates appeared to be closely related, and were much more closely related to A/Beijing/353/89, than to A/Shanghai/16/88.

The AFA cadets demonstrated the expected good HI antibody titers to A/Shanghai/16/88, with which antigen they had been vaccinated in the fall of 1990. The acute sera, however, showed very little HI antibody reactivity to the A/Beijing/353/89 antigen, and still less activity against the recent Colorado isolates. These data suggested that the A/Beijing/353/89 antigen would be a useful protective component for the 1991-92 influenza vaccine.

### **Decay of Antibody Titers During the Season**

A group of 25 students and 25 permanent party members at Lowry Air Force Base were re-bled at the end of April, 1991, approximately 6 months after their fall 1990 influenza vaccination. HI antibody titers determined 6 months after immunization were compared to titers pre- and 3 weeks post- vaccination. All antibody titers in this comparison were run simultaneously. The results are presented in Tables 6 (students) and 7 (permanent party). The two recently isolated Colorado strains were run, together with the A/Shanghai/16/88 vaccine antigen, and the A/Beijing/353/89 strain.

The failure of A/Shanghai to protect against A/Beijing or the A/Beijing-like Colorado isolates, especially 6 months after vaccination, is demonstrated in these sera as well. Note that the decline in HI antibody titer over 6 months is significant, and geometric mean titers declined to less than half of their 3-week post-vaccination levels in the recruit (student) population. In the permanent party, the antibody decline is much less dramatic, but their peak post-vaccination titers were not that high to begin with. Titers 6 months after vaccination are only slightly higher than pre-vaccination titers.

### **Summary, 1990-91**

Thus, the 1990-91 influenza season was marked by a modest outbreak of influenza B at Lowry Air Force Base that occurred during the months of January, February and March. A concurrent outbreak of influenza B occurred in the civilian population of Denver, moderately severe in nature.

A rather unusual late spring outbreak of influenza A/H3N2 occurred at the United States Air Force Academy, and to a lesser extent in a civilian community

near Denver. Only one cases occurred at Lowry Air Force Base. This outbreak was widely believed to represent a "herald" wave, and presaged an early and possibly severe outbreak of influenza in the next season.

### **1991-92 SEASON**

#### **Response to Vaccination**

The vaccine formulation for the 1991-92 season was changed to update two antigens, the influenza A/H3N2 component and the influenza B component. The vaccine contained 15 mcg. each of A/Beijing/353/89 (H3N2), A/Taiwan/1/86 (H1N1), and B/Panama/45/90.

Vaccination at Lowry Air Force Base began on 1 October, 1991. A total of 37 permanent party members were bled prior to vaccination on 1 October and again on 22 October, 1991. They were divided into 2 groups based on their duration of service in the Air Force. Table 8 shows the vaccine response data, in HI antibody titers, for those who had been in the Air Force for 1 to 5 years, and Table 9 shows comparable data for those with 6 to 20 years of service.

Pre- and post-vaccination sera were also received from Air Force recruits who were vaccinated on entry at Lackland Air Force Base. These recruits were bled and vaccinated during the week of 6 January 1992, and re-bled during the week of 27 January 1992. Their HI antibody titers are summarized in Table 10.

Note first the brisk HI antibody response seen in recruits (Table 10). Close to 90% or more of recruits developed  $\geq 4$ -fold increases in titer, and, at least for the two influenza A antigens, 90% or more achieved titers of 1:  $\geq 64$ , a level that has correlated well with clinical protection as measured in field trials. The response to the B/Panama/45/90 antigen was less brisk, but still quite satisfactory.

Inspection of Tables 8 and 9 makes it evident that the permanent party members who had been in the service 1 to 5 years represented a group that was intermediate in their vaccine response between the recruits on the one hand, and the more seasoned, and presumably older, permanent party personnel on the other hand. In the 1-5 year service personnel, vaccine response was still quite good, and a high level of protection could be anticipated. Note also that pre-vaccine antibody titers were quite high, in sharp contrast to the situation in recruits.

The 6-20 year service personnel also demonstrated moderate pre-vaccine HI antibody titers, particularly for the H1N1 antigen. The overall vaccine response in this group is satisfactory, but certainly less so than in younger personnel.

### **Occurrence of Febrile Upper Respiratory Infections**

Because of the late spring 1991 "herald" wave of influenza A/H3N2, we anticipated influenza presenting earlier than usual during the 1991-92 season. Accordingly, surveillance at the Base Clinic was initiated on 24 September 1991, and continued through the end of May 1992. The surveillance methodology in use was the same as in previous years. Serum specimens from patients seen in the clinic were tested for influenza A and B, adenovirus, respiratory syncytial virus, and parainfluenza 1, 2, and 3. Throat washings were tested for influenza A and B, other respiratory viruses including parainfluenza and rhinoviruses, and chlamydia and mycoplasma. The total number of clinic visits per week, the number with URI symptoms, and the number of patients with febrile upper respiratory infections is shown in Table 11.

Influenza A did indeed occur early in some parts of the United States during the 1991-92 season. In Texas and Tennessee, outbreaks with extensive school absenteeism were reported in October and November. Inspection of Table 11, however, makes it apparent that there was no major outbreak at Lowry Air Force Base. There was, however, a significant outbreak during December and January in the metropolitan Denver area surrounding the base.

The positive cultures from Lowry Air Force Base for the 1991-92 season are shown in Table 12. A total of 16 cases of influenza A/H3N2 were detected at Lowry Air Force Base during the 1991-92 season; all cases occurred during the month of December 1992. All of the cases occurred among the permanent party; no cases occurred in students. Twelve of the cases were confirmed by virus isolation, and the remaining 4 cases were confirmed a  $\geq 4$ -fold titer rise in both complement-fixing antibody and HI antibodies. All of the virus isolates were A/Beijing/353/89-like.

Three cases of influenza B occurred in March 1992, one confirmed by virus isolation and two by serologic testing. Other respiratory pathogens detected on the base during the 1991-92 season included Group A beta-hemolytic streptococci (8 isolates), herpes simplex virus, and parainfluenza viruses, types 1, 2, 3, and 4.

### **Decay of Antibody Titers During the Season**

In order to assess the decay of HI antibody titers over the preceding 6 to 7 months, a group of 29 students and another of 24 permanent party personnel

were bled in April 1992, and the HI antibody titers determined using as antigens the virus strains that had been used in the 1991-92 vaccine. The results are presented in tables 13 and 14.

Note that there had been some decline in antibody levels in both groups compared to the 3-week post-vaccine titers, presented in Tables 8-10. The majority of both students and permanent party still had protective levels of HI antibody against the influenza A/H3N2 strain, A/Beijing/353/89; only about half of each population still had protective antibody levels against influenza A/H1N1 and influenza B. Overall, post-season HI antibody titers in both students and permanent party were quite comparable.

### **Summary, 1991-92**

The 1991-92 influenza season was actually quite unremarkable at Lowry Air Force Base. The anticipated early outbreak of influenza A/H3N2 was seen in some parts of the country, but not until December in Colorado. Only 16 cases of influenza A were seen on base, and all of those in permanent party.

The complete protection of students at Lowry against influenza A must be attributed to their excellent response to the vaccine, and to the fact that there was quite a good "match" between the A/Beijing/353/89 vaccine antigen and the strain of influenza A/H3N2 that circulated during that season.

## **1992-93 SEASON**

### **Response to Vaccination**

The vaccine formulation for the 1992-93 season was changed slightly from the previous year; the influenza A/H1N1 component was updated with a new strain. The vaccine contained 15 mcg. each of A/Beijing/353/89 (H3N2), A/Texas/36/91 (H1N1), and B/Panama/45/90.

Vaccination began at Lowry Air Force Base in mid-October 1992. A group of 56 members of the permanent party were bled on 22 October 1992 just prior to receiving vaccine, and again three weeks later on 12 November 1992. Unfortunately, no serum specimens from recruits at Lackland Air Force Base were obtained during the 1992-93 season, and hence the determination of vaccine response was limited to permanent party personnel, who were between the ages of 20 and 55 years.



Serologic assessment of vaccine response in the fall of 1992 was carried out as part of a cooperative endeavor organized by Dr. Nancy Cox of the WHO Influenza Center for the Americas, located at the Centers for Disease Control, and Dr. Roland Levandowski of the Division of Virology, Center for Biologics Evaluation and Research, Food and Drug Administration. The objective was to determine the inter-laboratory variability when a standard protocol for HI antibody testing was followed, using common and standardized reagents and antigens.

The data are presented in Tables 15-17; one table is devoted to each major antigenic type in the vaccine. Because of the cooperative study, several antigens in each type were tested, the only exception being the single H1N1 antigen tested.

Influenza A/H3N2: The response to the vaccine antigen, A/Beijing/353/89, is typical of the vaccine responses seen in permanent party personnel, and is certainly muted when compared to what has been repeatedly observed in previous years in Air Force recruits. Nonetheless, over 80% of vaccinees developed an HI antibody titer of 1:  $\geq 40$ , a level of antibody that is considered protective. Response to other more recently identified H3N2 strains was disappointing, however. Only 30-40% of vaccinees were adequately protected against the 2 1992 isolates, A/Hong Kong/23/92 and A/Beijing/32/92.

Influenza A/H1N1: The only H1N1 antigen tested was the vaccine antigen, and the permanent party responded about as expected. About 70% of the group achieved a titer of 1:  $\geq 40$ , yet only 23% of vaccinees achieved a  $\geq 4$ -fold titer rise. Pre-vaccine titers were good, presumably a result of prior infection or vaccination.

Influenza B: Of note in this table is the dramatic difference in observed HI antibody titers when ether-split antigen is used, as compared to whole virus antigen. It is not clear, however, how the protective level of HI antibody correlates with these two test systems, so the significance of these results remains uncertain. It does underscore, however, that the HI antibody test is quite sensitive to how the test antigen is prepared.

### **Occurrence of Febrile Upper Respiratory Infection**

Surveillance during the 1992-93 season was initiated in 1 October 1992, and continued through the end of April, 1993. The surveillance system and the study methodology were the same as in previous years.

A tabulation of weekly clinic visits during the surveillance period is shown in Table 18. Note that the number of personnel, both students and permanent

party, seen with febrile respiratory disease each week was quite low, varying from 1 to 6, during most of the season. During the last week of February and the first two weeks of March, however, febrile respiratory disease activity increased sharply, but quickly fell to the usual levels again by the end of March, 1993.

This peak appeared to correlate with a somewhat later than usual winter outbreak of influenza A/H3N2 that occurred in the metropolitan Denver area, as well as elsewhere in the United States. Viruses circulating during that outbreak were, as predicted, more closely related to the A/Beijing/32/92 group of viruses than to the earlier A/Beijing/353/89 strain, the antigen that was used in the 1992-93 vaccine.

Respiratory pathogens recovered through the surveillance study at Lowry Air Force Base during the 1992-93 season are shown in Table 19. There were 6 isolates of Influenza B virus during the year, the first in December 1992, and the rest in February and March 1993. Only 1 of these cases was in a student, the remainder in permanent party personnel. All but 1 had been vaccinated in the fall of 1992. One additional case of influenza B in a permanent party member occurred in February 1993, and was confirmed serologically.

There were 16 cases of influenza A on the base, all occurring during the "outbreak" of febrile respiratory disease activity during late February, March, and very early April. Eleven cases were confirmed by virus isolation, and 5 by seroconversion. Only one case occurred in a student, and the balance in permanent party personnel. All but 3 of the 16 cases had received vaccine in the previous fall. As was true with the civilian isolates, the Lowry Air Force Base strains were A/Beijing/32/92-like. Thus, this moderate antigenic drift in the circulating influenza A/H3N2 virus, as demonstrated in the vaccine response data, resulted in protection that was somewhat less than optimal, particularly among the permanent party personnel.

There were 13 cases of adenovirus infection that occurred on the base during the 1992-93 season, 9 confirmed by virus isolation and 4 by seroconversion. Most of them occurred during February, March and April 1993. In contrast to the experience with influenza, all but one of the adenovirus infections occurred among students. This was the largest number of adenovirus infections seen at Lowry Air Force Base since the use of adenovirus vaccine was discontinued by the Air Force in the late 1980's.

Other respiratory pathogens detected during the 1992-93 season included herpes simplex virus ( 6 isolates ), parainfluenza type 3 ( 2 isolates ), rhinovirus ( 4 isolates ), *Chlamydia pneumoniae* ( 3 isolates ), and 6 cases of culture-positive group A streptococcal pharyngitis.



### **Decay of Antibody Titers During the Season**

In order to assess the decay of HI antibody titers during the 1992-93 season, 10 students and 20 permanent party personnel were bled during April 1993; the sera were tested for HI antibody using the three vaccine antigens as well as one additional influenza A/H3N2 strain, A/Beijing/32/92. That strain was representative of the influenza A/H3N2 viruses that circulated in the area during the 1992-93 season. The results are presented in Tables 20 and 21.

Although the student group was quite small, the results are nonetheless of interest. The level of HI antibodies directed against the vaccine antigen, A/Beijing/353/89, was quite high; the titer determined using the A/Beijing/32/92 antigen was much lower. However, only one case of influenza A/H3N2 was confirmed among students during the 1992-93 season; hence protective efficacy was evidently quite satisfactory. Antibody levels against the two remaining vaccine antigens, A/H1N1 and B, were also quite satisfactory. No comparison with 3-week post-vaccine titers was possible, inasmuch as no recruit or student sera were obtained during the fall of 1992.

Among the permanent party members (Table 21), levels had declined somewhat from the 3-week post-vaccine titers (Tables 15-17), although HI antibody titers against the A/Beijing/353/89 vaccine antigen were still surprisingly high. In contrast, HI antibody titers directed against the A/Beijing/32/92-like circulating strains were relatively low, and it was in the permanent party personnel that most of the cases of documented influenza occurred.

### **Summary, 1992-93**

Overall, the 1992-93 influenza season was relatively quiet at Lowry Air Force Base. There was a mixed outbreak of influenza in the surrounding community, marked by influenza B that occurred in January and February, followed by influenza A/H3N2 that occurred later, in February, March, and early April. The civilian outbreak was mirrored in a limited way at Lowry Air Force Base, with a handful of cases of influenza B, but a somewhat sharper outbreak of influenza A/H3N2, particularly apparent among permanent party members.

This experience underscores the reduced efficacy of influenza vaccine in older permanent party personnel, as compared to the younger recruits, when there has been modest antigenic drift in the virus, and the match between the circulating strain and the vaccine strain is less than optimal.

### **1993-94 SEASON**

The preceding season was mixed, and, as noted above, was characterized by a modest outbreak of influenza B, followed later in the winter and spring of 1993 by a sharper outbreak of influenza A/H3N2, due to a virus that had drifted antigenically from the strain in the vaccine for that year. Consequently, we wondered again whether the late outbreak of influenza A/H3N2 represented a "herald wave", and, if so, whether it would predict an early and possibly severe outbreak during the 1993-94 season.

That concern was underscored by some civilian outbreaks of influenza A/H3N2 that occurred in August and September 1993.

#### **Base Population**

In the three preceding years, the base population had remained relatively stable at about 2000-2500 students and 3000-4000 permanent party personnel, the base population began to decline sharply during the 1993-94 season. The base was scheduled to close completely and be decommissioned in September 1994.

In September 1993, the population consisted of about 2000 students and 3000 permanent party personnel. By the last week of April 1995, the student population had declined to only 200-300, and the permanent party to about 1200 officers and enlisted men. During May 1994, the last of the students left the base, and most of the remaining permanent party left during the months of June-September 1994.

#### **Response to Vaccination**

Reflecting the concern about continuing antigenic drift in influenza A/H3N2, that antigen was updated to a more recent isolate in the 1993-94 vaccine formulation. The vaccine contained 15 mcg. each of A/Beijing/32/92 (H3N2), A/Texas/36/91 (H1N1), and B/Panama/45/90.

Vaccination began at Lowry Air Force Base in early October 1993. Since we were unable to obtain pre- and post-vaccine sera from newly-inducted recruits at Lackland Air Force Base, we instead obtained pre-and post-vaccine sera from 48 students at Lowry Air Force Base. These students had been recruited

into the Air Force during the preceding year, and all had received the previous 1992-93 vaccine previously, usually 3 to 10 months earlier.

Similarly, pre-and post vaccine sera were obtained from permanent party members. There were 11 paired sera, 8 pre-vaccine sera only, and 14 post-vaccine sera only.

All sera were tested for HI antibody response to the 3 vaccine antigens, and to 2 other antigens as well. These were a recent influenza A/H3N2 isolate from the Denver civilian community, A/Denver/1/93, and an older A/H1N1 strain, A/Taiwan/1/86. The results are present in Tables 22 and 23.

Among the students, the pre-vaccine titers were much higher than seen previously among Air Force recruits; this was clearly a result of receipt of the 1992-93 vaccine upon induction into the Air Force. Consequently, there were far fewer  $\geq 4$ -fold antibody rises than seen previously. Nonetheless, virtually all students developed protective antibody titers to the influenza A/H3N2 and H1N1 components, and almost 80% achieved protective antibody titers to influenza B. Response to the A/Denver/1/93 antigen was not as good as with the vaccine antigen, again suggesting continuing antigenic drift among the influenza A/H3N2 viruses.

Antigenic response in the permanent party personnel was relatively poor, compared to the younger student population. This muted response in the older permanent party personnel has been observed repeatedly in the past, and undoubtedly accounts for the fact that almost all of the influenza seen on the base in recent years has occurred in permanent party personnel. The response to the influenza B antigen was particularly poor.

### **Occurrence of Febrile Upper Respiratory Tract Infection**

Surveillance was initiated at Lowry Air Force Base in early October 1993, and continued through the end of April 1994. The surveillance system and the study methodology were the same as in previous years. The weekly number of personnel seen with febrile respiratory disease is shown in Table 24. Only the numbers with febrile URI's were available. Nonetheless, it is clear that the overall numbers are down markedly from previous years, a reflection of the declining base population. It is also clear that there was no unusual febrile URI activity during the surveillance period save for a brief burst of activity, mostly among permanent party personnel, in very early January.

This small peak coincided closely with an outbreak of influenza A/H3N2 in the civilian population of metropolitan Denver, and coincided well also with a sharp national outbreak.

Respiratory pathogens identified during the 1993-94 surveillance period are shown in Table 25. Influenza A/H3N2 was identified in 10 cases, and 3 additional cases were confirmed by seroconversion. All influenza isolates were A/Beijing/32/92-like, and all confirmed cases occurred in permanent party personnel. Most of the cases occurred in late December 1993 and January 1994, correlating well with the increase in clinic visits seen in Table 24, and also correlating well with the influenza A/H3N2 outbreak in the surrounding civilian community.

Adenovirus, Herpes simplex, and *Mycoplasma pneumoniae* were each recovered once during the season, and there were 4 isolates of parainfluenza viruses, one type 1, and three type 4. There were no isolates of Group A beta-hemolytic streptococci, but the number of cultures submitted was very low.

Owing to the sharply declining base population during April 1994, and the imminent closure of the base clinic, no end-of season sera were obtained.

### **Summary 1993-94**

The 1993-94 season followed the pattern seen in the previous several years. There was a sharp outbreak of A/H3N2 influenza nationally that was experienced in the Denver metropolitan area as well. The student population at Lowry Air Force Base was fully protected, and no cases of influenza were detected in that population. The permanent party personnel were less well protected, and 13 cases of influenza A were identified. Overall, however, the base population was well protected by the vaccine, compared to the generally unimmunized civilian population.

### **CONCLUDING PERSPECTIVES ON INFLUENZA IN THE ARMED FORCES**

Table 26 shows the number of cases of influenza confirmed by virus isolation or serologic diagnosis from persons with febrile upper respiratory disease at the Lowry Air Force Base clinic during the previous 12 seasons, 1982-94.

Influenza A/H3N2 continues to be regarded as the most virulent of the three major antigenic types of influenza viruses. As shown in Table 26, the student population has been almost completely protected against that virus, and that protection must be attributed almost wholly to vaccination.

The permanent party has also fared quite well against A/H3N2 strains, albeit clearly less well than the students. Although permanent party members have

responded well to vaccination, their resulting antibody titers have been less than those observed among students, and the protective efficacy has been less. Our data do not permit calculation of attack rates in permanent party personnel and students for the last 5 years, since base population figures are incomplete.

Influenza A/H1N1 strains have caused little disease in the United States since the 1988-89 season, and the experience at Lowry Air Force Base certainly reflects that. Response to the A/H1N1 vaccine antigen has been quite good, suggesting that infection with this or a closely related A/H1N1 virus has been almost universal at some time in the past.

Influenza B viruses have been unpredictable, and response to the B antigen in the vaccine has been uneven at best. The selection of vaccine strains for influenza B may not have been optimal prior to 1989, and the numbers of cases of influenza B seen since then has diminished.

Thus, current influenza vaccines have generally been highly effective in preventing influenza among members of the armed forces. When there has been antigenic drift of the virus, particularly influenza A/H3N2, so that the vaccine strain is not closely matched to the wild, circulating strain, protective efficacy has diminished. Nonetheless, the record of the last 14 years has been quite good, and the current systems of worldwide influenza surveillance and strain identification have permitted us to predict the character of circulating influenza strains in the season ahead with more confidence than previously.

The past 14 years, however, have been marked by gradual antigenic drifting of influenza viruses, and we have not experienced the dramatic antigenic shifts that characterized influenza epidemiology during the 1950's, 1960's, and 1970's. As recently as the 1977-78 season, an explosive outbreak of influenza A/H1N1, due to A/USSR/90/77, the "Russian flu", occurred at Lowry Air Force Base; an estimated 30% of the entire student population became ill due to this virus within a 3-week period. It was a vivid reminder of the epidemic threat of influenza A viruses should a new strain emerge and spread in a susceptible population.

The inference to be drawn is that the salutary experience of the past 15 years or more should not be expected to continue indefinitely. Influenza viruses have surprised epidemiologists and virologists frequently in the past, and will continue to do so in the future. The U.S. Army Medical Research and Development Command is urged to remain alert to the threat of epidemic influenza in the future.

Table 1

HI antibody titers of pre and post vaccination sera of 87 students (Lackland AFB). Vaccine given contained 15 mcg. each of A/Shanghai/16/89, A/Taiwan/1/86, and B/Yamagata/16/87. Dates of the pre and post sera were 10/15/90 and 11/15/90. Ages 17-22.

<u>Antigen</u>	<u>Serum</u>	<u>Cumulative % with Titer of</u>											GMT	% with $\geq 4$ <u>fold rise</u>
		<8	8	16	32	64	128	256	512	1024				
A/Shanghai 16/89	pre	21	79	59	26	10	5	2	2	-	-	15	78	
	post	1	99	99	94	81	72	58	34	17	189			
A/Taiwan 1/86	pre	34	66	45	28	15	9	3	-	-	-	13	82	
	post	3	95	93	92	89	82	59	42	16	215			
B/Yamagata 16/87	pre	34	64	30	13	3	1	-	-	-	-	9	91	
	post	1	99	99	98	85	72	53	32	13	182			

Table 2

HI antibody titers of pre and post vaccination sera of 28 permanent party (Lowry AFB). Vaccine given contained 15 mcg. each of A/Shanghai/16/89, A/Taiwan/1/86, and B/Yamagata/16/87. Dates of pre and post were 10/25/90 and 11/15/90. Ages 22-45. \*

Antigen	Serum	Cumulative % with Titer of												GMT	% with $\geq 4$ fold rise
		<8	8	16	32	64	128	256	512	1024					
A/Shanghai 16/89	pre	-	99	78	57	36	15	11	7	-			33	14	
	post	-	98	91	79	43	22	11	11	4			49		
A/Taiwan 1/86	pre	4	97	79	65	33	15	4	4	-			30	25	
	post	-	100	100	86	54	33	8	4	-			57		
B/Yamagata 16/87	pre	7	93	86	68	36	11	-	-	-			30	21	
	post	4	96	96	78	57	32	7	-	-			51		

\* All 28 persons had received influenza vaccine in the military for at least 3 years and in some instances as many as 15-20 years prior to this year's vaccination.

Table 3.

## Weekly Clinic Visits with Upper Respiratory Infections, Lowry AFB, 1990-91

Week of	Clinic Total	URI w/o Temp	URI with Temp		
			99.6/above	Stud	PP
1-Oct	355	8	15	5	10
8-Oct	369	19	13	8	5
15-Oct	409	22	14	6	8
22-Oct	480	26	12	3	9
29-Oct	425	9	9	5	4
5-Nov	390	19	16	6	10
12-Nov	367	21	6	1	5
19-Nov	348	13	6	2	4
26-Nov	450	15	12	6	6
3-Dec	492	26	9	7	2
10-Dec	425	26	12	10	2
17-Dec	444	18	11	4	7
24-Dec	155	2	2	0	2
31-Dec	218	8	10	4	6
7-Jan	385	20	15	7	8
14-Jan	364	18	9	3	6
21-Jan	365	15	11	3	8
28-Jan	348	9	17	7	10
4-Feb	596	31	12	1	11
11-Feb	481	20	25	11	14
18-Feb	440	25	15	5	10
25-Feb	386	26	11	5	6
4-Mar	529	28	9	2	7
11-Mar	509	25	12	4	8
18-Mar	558	22	10	3	7
25-Mar	647	21	19	5	14
1-Apr	410	11	19	11	8
8-Apr	429	2	6	5	1
15-Apr	470	0	2	1	1
22-Apr	541	12	5	0	5
29-Apr	434	5	4	2	2
6-May	449	16	3	0	3
13-May	473	18	6	0	6
20-May	415	13	1	1	0
27-May	173	7	3	0	3
Total	14729	576	361	143	218



Table 4. Documented Cases of Influenza B, Lowry AFB, 1990-91

Age	Stat	Vacc	Onset	CF B	HI B/Yama	RMK * Cult
22	S	+	1/18/91	<8 8	<8 64	-
24	P	+	1/22/91	<8 8	8 32	-
29	P	+	1/29/91	<8 16	128 128	+
27	P	+	1/29/91	8 64	8 64	-
38	P	+	1/29/91	8 32	<8 16	+
34	P	+	1/30/91	8 32	32 32	-
34	P	+	1/30/91	8 64	8 32	+
37	P	+	1/31/91	8 32	<8 16	+
30	P	+	2/4/91	8 64	8 64	+
31	P	+	2/6/91	8 64	8 32	+
31	P	+	2/8/91	<8 32	<8 64	+
23	S	-	2/11/91	<8 128	<8 64	-
44	P	+	2/11/91	8 64	<8 32	-
43	P	+	2/11/91	8 64	8 256	-
22	P	NV	2/12/91	8 128	8 64	+
18	S	+	2/12/91	8 32	<8 128	+
29	P	+	2/14/91	8 64	<8 64	+
43	P	+	2/15/91	8 32	8 32	-
27	P	+	2/15/91	8 8	<8 16	+
18	S	+	2/20/91	<8 32	<8 32	+
30	P	+	3/12/91	<8 32	8 64	-

\*Rhesus Monkey  
Kidney

Table 5

Distribution of HI titers for A(H3N2) strains in 20  
Air Force Academy cadets ill with influenza during April 1991

Group	Virus tested	#	Serum	<8	Cumulative %								1024	GMT	% $\geq$ 4X rises
					8	16	32	64	128	256	512	1024			
AFA	CF A	20	acute conv	45	55	10	0	0	0	0	0	0	0	6	40
				10	90	65	30	5	0	0	0	0	0	15	
AFA	A/Shang 16/88	20	acute conv	0	100	100	95	70	40	10	0	0	0	71	20
				0	100	100	100	95	70	30	10	0	0	133	
AFA	A/Beijing 353/89	20	acute conv	35	65	40	20	5	0	0	0	0	0	10	65
				5	95	90	85	60	25	10	0	0	0	50	
AFA	**A/Colo 1/91	20	acute conv	25	75	40	15	0	0	0	0	0	0	10	55
				5	95	95	70	35	10	0	0	0	0	33	
AFA	***A/Colo 443/91	20	acute conv	45	55	30	25	0	0	0	0	0	0	9	60
				5	95	95	85	40	15	5	0	0	0	41	

\*\*Strain isolated from  
17yo. Colo. Resident

\*\*\* Strain isolated from  
AFA Cadet

Table 6

Distribution of HI Titers for A(H3N2) strains in AF Permanent Party at Lowry AFB  
who recieved vaccine containing A/Shanghai/16/88 in the fall of 1990

Group	Virus tested	#	Serum	<8	8	16	32	Cumulative %				1024	GMT	% $\geq$ 4X rises
								64	128	256	512			
Lowry PP	A/Shang 16/88	28	pre	0	99	78	57	36	15	11	7	0	33	10
		28	post	0	98	91	79	43	22	11	11	4	49	
		* 25	5 mo. post	12	88	80	52	44	36	16	4	0	37	
Lowry PP	A/Beijing 353/89	17	pre	35	65	24	6	6	0	0	0	0	8	12
		17	post	35	65	47	18	12	6	0	0	0	11	
		* 25	5 mo. post	35	65	46	31	15	8	8	4	4	12	
Lowry PP	**A/Colo 1/91	20	pre	30	70	40	15	5	5	5	5	0	11	10
		20	post	25	75	40	35	15	15	10	5	0	15	
		* 25	5mo. post	20	80	48	28	24	12	8	4	0	16	
Lowry PP	***A/Colo 443/91	20	pre	30	70	70	15	15	5	0	0	0	11	10
		20	post	35	65	55	35	25	15	5	0	0	16	
		* 25	5mo. post	36	64	64	28	24	20	12	0	0	15	

\*\*Strain isolated from  
17yo. Colo. Resident

\*\*\* Strain isolated from  
AFA Cadet

\* 6-7 mo. post vaccine blood drawn at the end of April 1991

Table 7

Distribution of HI Titers for A(H3N2) strains in AF Permanent Party at Lowry AFB who recieved vaccine containing A/Shanghai/16/88 in the fall of 1990

Group	Virus tested	#	Serum	<8	Cumulative %										1024	GMT	% ≥ 4X rises
					8	16	32	64	128	256	512						
Lowry PP	A/Shang 16/88	28	pre	0	99	78	57	36	15	11	7	0	33	10			
		28	post	0	98	91	79	43	22	11	11	4	49				
		* 25	5 mo. post	12	88	80	52	44	36	16	4	0	37				
Lowry PP	A/Beijing 353/89	17	pre	35	65	24	6	6	0	0	0	0	8	12			
		17	post	35	65	47	18	12	6	0	0	0	11				
		* 25	5 mo. post	35	65	46	31	15	8	8	4	4	12				
Lowry PP	**A/Colo 1/91	20	pre	30	70	40	15	5	5	5	5	0	11	10			
		20	post	25	75	40	35	15	15	10	5	0	15				
		* 25	5mo. post	20	80	48	28	24	12	8	4	0	16				
Lowry PP	***A/Colo 443/91	20	pre	30	70	70	15	15	5	0	0	0	11	10			
		20	post	35	65	55	35	25	15	5	0	0	16				
		* 25	5mo. post	36	64	64	28	24	20	12	0	0	15				

\*\*Strain isolated from 17yo. Colo. Resident

\*\*\* Strain isolated from AFA Cadet

\* 6-7 mo. post vaccine blood drawn at the end of April 1991

Table 8

H.I. titers of 20 permanent party at Lowry AFB before and after receiving Influenza vaccine containing 15ug each of A/Beijing/353/89 (H3N2), A/Taiwan/1/86 (H1N1), and B/Panama/45/90. These people were bled on 10/1/91 and 10/22/91 and had been in the service between 1 and 5 years.

(H3N2)		% of persons with HI titer $\geq$										% $\geq$ 4X rises	
A/Beijing/353/89		<8	8	16	32	64	128	256	512	1024		GMT	
CUM %	TITER	5	95	70	45	25	5	5	0	0		22	
	PRE												
	POST	0	100	100	90	75	45	25	10	5		91	45
(H1N1)		% of persons with HI titer $\geq$											
A/Taiwan/1/86		<8	8	16	32	64	128	256	512	1024			
CUM %	TITER	0	100	100	95	85	65	45	25	10		152	
	PRE												
	POST	0	100	100	100	95	85	65	30	10		231	20
B/Panama/45/90		% of persons with HI titer $\geq$											
		<8	8	16	32	64	128	256	512	1024			
CUM %	TITER	5	95	95	70	30	20	15	5	0		38	
	PRE												
	POST	0	100	100	95	75	35	25	15	5		91	30

Table 9

H.I. titers of 17 permanent party at Lowry AFB before and after receiving Influenza vaccine containing 15ug each of A/Beijing/353/89 (H3N2), A/Taiwan/1/86 (H1N1), and B/Panama/45/90. These people were bled on 10/1/91 and 10/22/91 and had been in the service between 6 and 20 years.

(H3N2) A/Beijing/353/89	TITER	% of persons with HI titer $\geq$							% $\geq$ 4X rises	
		<8	8	16	32	64	128	256	512	1024
CUM %	PRE	12	88	29	24	12	0	0	0	0
	POST	0	100	88	59	47	29	12	12	0
									12	
									44	53

(H1N1) A/Taiwan/1/86	TITER	% of persons with HI titer $\geq$								
		<8	8	16	32	64	128	256	512	1024
CUM %	PRE	0	100	82	71	47	30	6	6	0
	POST	0	100	100	88	71	47	29	12	0
									43	
									89	29

B/Panama/45/90	TITER	% of persons with HI titer $\geq$								
		<8	8	16	32	64	128	256	512	1024
CUM %	PRE	24	76	71	59	29	0	0	0	0
	POST	0	100	88	71	59	18	0	0	0
									20	
									41	24

Table 10

H.I. titers of 67 recruits at Lackland AFB before and after receiving influenza vaccine containing 15ug each of A/Beijing/353/89 (H3N2), A/Taiwan/1/86 (H1N1), and B/Panama/45/90. These people were bled on 1/8/92 and 2/4/92 and were between the ages of 17 and 28 years.

(H3N2)											
A/Beijing/353/89											
		% of persons with HI titer $\geq$									% $\geq$ 4X rises
TITER		<8	8	16	32	64	128	256	512	1024	GMT
PRE		21	79	31	16	9	5	2	0	0	11
POST		0	100	100	94	90	73	61	45	30	243
CUM %											88
(H1N1)											
A/Taiwan/1/86											
		% of persons with HI titer $\geq$									GMT
TITER		<8	8	16	32	64	128	256	512	1024	
PRE		28	72	60	45	28	15	5	0	0	19
POST		0	100	100	100	100	94	91	75	51	551
CUM %											96
B/Panama/45/90											
		% of persons with HI titer $\geq$									GMT
TITER		<8	8	16	32	64	128	256	512	1024	
PRE		64	36	15	8	3	0	0	0	0	6
POST		3	97	94	87	78	66	42	27	10	128
CUM %											90

Table 11

## Weekly Clinic Visits with Upper Respiratory Infection, Lowry AFB 1991-92

Week of	Clinic Total	URIw/o Temp	URI with Temp		
			99.6/above	Stud.	PP
23-Sep	378	15	9	4	5
30-Sep	518	18	4	1	3
7-Oct	433	16	4	0	4
14-Oct	355	10	5	2	3
21-Oct	442	17	9	1	8
28-Oct	424	10	5	2	3
4-Nov	414	8	3	1	2
11-Nov	314	9	3	2	1
18-Nov	427	11	6	1	5
25-Nov	196	6	4	2	2
2-Dec	481	18	7	1	6
9-Dec	477	13	6	1	5
16-Dec	523	12	10	0	10
23-Dec	173	4	5	0	5
30-Dec	213	3	2	0	2
6-Jan	411	4	3	0	3
13-Jan	464	2	3	2	1
20-Jan	303	3	1	0	1
27-Jan	522	7	4	2	2
3-Feb	474	4	3	3	0
10-Feb	410	8	5	2	3
17-Feb	389	5	3	3	0
24-Feb	427	5	3	2	
2-Mar	328	3	0	0	0
9-Mar	428	9	2	1	1
16-Mar	370	3	3	1	2
23-Mar	370	0	1	0	1
30-Mar	411	9	0	0	0
6-Apr	448	2	5	1	4
13-Apr	474	0	1	1	0
20-Apr	441	8	2	2	0
27-Apr	408	0	0	0	0
4-May	449	6	2	2	0
11-May	408	5	3	1	2
18-May	420	11	4	4	0
25-May	86	161	1	1	1
Total	14209	425	131	46	85



Table 12

## Respiratory Pathogens Isolated at Lowry AFB, 1991-92

Date	Stat	Vacc	Temp	Strep	Culture Viral	Result
12/4/91	P	Sep-91	99.6	ND *	Flu A	A/BJ/353/89
12/12/91	P	Oct-91	99.8	ND *	Flu A	A/BJ/353/89
12/12/91	P	Oct-91	100.8	ND *	Flu A	A/BJ/353/89
12/16/91	P	Oct-91	102.1	neg	Flu A	A/BJ/353/89
12/17/91	P	Oct-91	102.6	ND *	Flu A	A/BJ/353/89
12/17/91	P	Nov-91	100.5	ND *	Flu A	A/BJ/353/89
12/17/91	P	Oct-91	99.6	ND *	Flu A	A/BJ/353/89
12/17/91	P	NV	99.4	ND *	Flu A	A/BJ/353/89
12/19/91	P			ND *	Flu A	A/BJ/353/89
12/26/91	P	Oct-91	99.4	ND *	Flu A	A/BJ/353/89
12/27/91	P	Oct-91	102	ND *	Flu A	A/BJ/353/89
12/30/91	P	Oct-91	102.3	ND *	Flu A	A/BJ/353/89

Date	Stat	Vacc	Temp	Strep	Culture Viral	Result
3/26/92	P	NV	98.6	ND *	Pos	B/Pan/45/90

Date	Stat	Vacc	Temp	Strep	Culture Viral	Result
10/9/91	P	Sep-91	102	+	-	Beta Gp A
11/18/91	S	Oct-91	100.3	+	-	Beta Gp A
11/21/91	P	Oct-91	101.7	+	-	Beta Gp A
11/27/91	S	Sep-91	98.1	+	-	Beta Gp A
12/10/91	P	Sep-91	98.2	+	-	Beta Gp A
12/17/91	P	Oct-91	103.1	+	-	Beta Gp A
12/27/91	P	Nov-91	102.5	+	-	Beta Gp A
12/27/91	P	Oct-91	101	+	-	Beta Gp A

Date	Stat	Vacc	Temp	Strep	Culture Viral	Result
10/15/91	P	Oct-91	97	ND *	Pos	HSV

Table 12 cont.

## Respiratory Pathogens Isolated at Lowry AFB, 1991-92

Date	Stat	Vacc	Temp	Culture		Result
				Strep	Viral	
10/23/91	P	Oct-91	100.9	ND *	Pos	Para 4
11/18/91	S	Oct-91	101.4	ND *	Pos	Para 2
11/22/91	P	Sep-91	99.9	neg	Pos	Para 1
2/20/92	S	Oct-91	100.3	ND *	Pos	Para 1
5/14/92	S	Mar-92	99.8	ND *	Pos	Para 3
5/15/92	P	Oct-91	99.2	ND *	Pos	Para 3

\* Not Done (ND)

Table 13

Distribution of post H.I. titers \* of 29 students at Lowry AFB who received vaccine containing 15mcg. each of A/Beijing/353/89, A/Taiwan/1/86, and B/Panama/45/90 in the fall of 1991

A/Beijing/353/89												GMT
CUM %	TITER	<8	8	16	32	64	128	256	512	1024		122
		100	100	97	86	72	62	38	24	14		
A/Taiwan/1/86												
CUM %	TITER	<8	8	16	32	64	128	256	512	1024		87
		100	100	97	76	66	55	31	17	3		
B/Panama/45/90												
CUM %	TITER	<8	8	16	32	64	128	256	512	1024		48
		100	93	90	59	48	35	28	7	0		

\*post vaccine blood drawn April 1992

Table 14

Distribution of post H.I. titers \* of 24 Permanent Party at Lowry AFB who recieved vaccine containing 15mcg. each of A/Beijing/353/89, A/Taiwan/1/86, and B/Panama/45/90 in the fall of 1991

A/Beijing/353/89												GMT
CUM %	TITER	<8	8	16	32	64	128	256	512	1024		
		100	92	88	88	71	54	38	25	8		99
A/Taiwan/1/86												
CUM %	TITER	<8	8	16	32	64	128	256	512	1024		
		100	92	88	75	50	38	21	4	0		51
B/Panama/45/90												
CUM %	TITER	<8	8	16	32	64	128	256	512	1024		
		100	92	80	67	54	46	29	13	0		55

\*post vaccine blood drawn April 1992

Table 15

H.I. titers of 56 Permanent Party at Lowry AFB before and after receiving influenza vaccine containing 15ug each of A/Beijing/353/89 (H3N2), A/Texas/36/91 (H1N1), and B/Panama/45/90. These people were bled on 10/22/92 and 11/12/92 and were between the ages of 20 and 55 years.

A/Beijing/353/89 (H3N2)													
TITER													
	<10	10	20	40	80	160	320	640	1280	TOTAL			
CUM %	PRE	7	93	79	50	23	11	2	0	0	0	100	
	POST	2	98	96	82	57	29	13	4	0	0	100	
													25
													GMT
													30
													69
													% $\geq$ 4X rises
A/Hong Kong/23/92 (H3N2)													
TITER													
	<10	10	20	40	80	160	320	640	1280	TOTAL			
CUM %	PRE	29	71	39	25	14	5	2	0	0	0	100	
	POST	18	82	68	39	29	9	0	0	0	0	100	
													15
													24
													13
A/Beijing/32/92 (H3N2)													
TITER													
	<10	10	20	40	80	160	320	640	1280	TOTAL			
CUM %	PRE	36	64	23	16	7	4	0	0	0	0	100	
	POST	21	79	45	29	14	2	0	0	0	0	100	
													11
													16
													11
A/Hong Kong/34/90 (H3N2)													
TITER													
	<10	10	20	40	80	160	320	640	1280	TOTAL			
CUM %	PRE	16	54	29	18	7	4	0	0	0	0	100	
	POST	29	71	48	29	18	5	0	0	0	0	100	
													11
													16
													14

Table 16

H.I. titers of 56 Permanent Party at Lowry AFB before and after receiving influenza vaccine containing 15ug each of A/Beijing/353/89 (H3N2), A/Texas/36/91 (H1N1), and B/Panama/45/90. These people were bled on 10/22/92 and 11/12/92 and were between the ages of 20 and 55 years.

		A/Texas/36/91 (H1N1)										GMT	% $\geq$ 4X rises
TITER	CUM %	<10	10	20	40	80	160	320	640	1280	TOTAL		
PRE	29	71	52	39	20	9	2	2	2	2	100	20	
POST	18	82	80	68	38	16	2	2	2	2	100	37	23

Table 17

H.I. titers of 56 Permanent Party at Lowry AFB before and after receiving influenza vaccine containing 15ug each of A/Beijing/353/89 (H3N2), A/Texas/36/91 (H1N1), and B/Panama/45/90. These people were bled on 10/22/92 and 11/12/92 and were between the ages of 20 and 55 years.

B/Panama/45/90 (Whole Antigen)													GMT	% $\geq$ 4X rises
TITER	<10	10	20	40	80	160	320	640	1280	TOTAL				
CUM %	PRE	32	68	38	21	16	5	2	0	0	100	14		
	POST	14	86	59	41	25	11	2	0	0	100	24	9	

B/Panama/45/90 (Ether Split Antigen)													GMT	% $\geq$ 4X rises
TITER	<10	10	20	40	80	160	320	640	1280	TOTAL				
CUM %	PRE	5	95	93	79	63	38	16	5	2	100	74		
	POST	4	96	96	96	82	61	29	9	4	100	133	33	

B/Victoria/2/87 (Whole Antigen)													GMT	% $\geq$ 4X rises
TITER	<10	10	20	40	80	160	320	640	1280	TOTAL				
CUM %	PRE	45	55	27	11	5	0	0	0	0	100	10		
	POST	41	59	32	16	5	0	0	0	0		11	7	

B/Victoria/2/87 (Ether Split Antigen)													GMT	% $\geq$ 4X rises
TITER	<10	10	20	40	80	160	320	640	1280	TOTAL				
CUM%	PRE	9	91	88	70	50	23	7	2	0	100	49		
	POST	5	95	93	82	63	34	13	4	0		71	20	

Table 18

## Weekly Clinic Visits with Upper Respiratory Tract Infection, Lowry AFB, 1992-93

Week of	Clinic Total	URI w/o Temp	URI with Temp		
			99.6 /above	Stud	PP
1-Oct	127		4	3	1
5-Oct	479		6	3	3
12-Oct	291		6	2	4
19-Oct	457		5	2	3
26-Oct	484	223	6	2	4
2-Nov	385		0	0	0
9-Nov	328		0	0	0
16-Nov	377		2	0	2
23-Nov	288		0	0	0
30-Nov	422	176	3	0	3
7-Dec	480		6	4	2
14-Dec	436		2	2	0
21-Dec	166		2	0	2
28-Dec	200	221	1	0	1
4-Jan	493		4	0	4
11-Jan	508		1	0	1
18-Jan	400		4	3	1
25-Jan	533	264	5	2	3
1-Feb	661		4	2	2
8-Feb	578		5	2	3
15-Feb	456		5	2	3
22-Feb	617	170	6	3	3
1-Mar	646		9	7	2
8-Mar	519		20	7	13
15-Mar	557		6	1	5
22-Mar	624		7	1	6
29-Mar	534	163	6	1	5
5-Apr	459		5	4	1
12-Apr	440		2	2	0
19-Apr	531		1	1	0
26-Apr	446	68	2	1	1
Total	13922	1285	135	57	78



Table 19

## Respiratory Pathogens Isolated at Lowry AFB, 1992-93

Date	Stat	Vacc	Temp	Culture				Result
				Strep	C. Pneu	M. Pneu	Viral	
10/22/92	P	NV	98.8	ND *	ND	ND	Pos	Adenovirus
10/19/92	S	Jul-92	100.7	ND *	ND	ND	Pos	Adenovirus
2/9/93	S	Nov-92	99.7	ND *	neg	neg	Pos	Adenovirus
2/17/93	S	Jan-93	99.9	ND *	neg	neg	Pos	Adenovirus
2/26/93	S	Dec-92	100.1	ND *	neg	neg	Pos	Adenovirus
3/5/93	S	Jan-93	99.5	ND *	neg	neg	Pos	Adenovirus
3/10/93	S	Dec-92	99.3	ND *	neg	neg	Pos	Adenovirus
4/9/93	S	Dec-92	101.6	ND *	neg	neg	Pos	Adenovirus
4/19/93	S	Jan-93	99.8	ND *	neg	neg	Pos	Adenovirus

Date	Stat	Vacc	Temp	Culture				Result
				Strep	C. Pneu	M. Pneu	Viral	
2/23/93	P	Oct-92	102.4	ND *	neg	neg	Pos	Flu A *
2/24/93	S	NV	99.7	ND *	neg	neg	Pos	Flu A *
3/11/93	P	Oct-92	99	ND *	neg	neg	Pos	Flu A *
3/12/93	P	NV	100.8	ND *	neg	neg	Pos	Flu A *
3/16/93	P	Oct-92	100.6	ND *	neg	neg	Pos	Flu A *
3/16/93	P	Oct-92	99.9	ND *	neg	neg	Pos	Flu A *
3/22/93	P	Oct-92	101.1	ND *	neg	neg	Pos	Flu A *
3/22/93	P	Oct-92	101.3	ND *	neg	neg	Pos	Flu A *
4/1/93	P	NV	101	ND *	neg	neg	Pos	Flu A *
4/1/93	P	Oct-92	100.7	ND *	neg	neg	Pos	Flu A *
4/1/93	P	Oct-92	101.5	ND *	neg	neg	Pos	Flu A *

\* A/BJ/32/92

Date	Stat	Vacc	Temp	Culture				Result
				Strep	C. Pneu	M. Pneu	Viral	
12/11/92	P	Oct-92	100.8	ND *	ND	ND	Pos	Flu B *
2/10/93	S	Oct-92	101.5	ND *	neg	neg	Pos	Flu B *
2/11/93	P	Oct-92	100.1	ND *	neg	neg	Pos	Flu B *
2/26/93	P	Nov-92	98.8	ND *	neg	neg	Pos	Flu B *
3/5/93	P	NV	100.5	ND *	neg	neg	Pos	Flu B *
3/10/93	P	Oct-92	98	ND *	neg	neg	Pos	Flu B *

\* B/Pan/45/90

Table19 cont.

## Respiratory Pathogens Isolated at Lowry AFB, 1992-93

Date	Stat	Vacc	Temp	Culture				Result
				Strep	C. Pneu	M. Pneu	Viral	
10/19/92	S	Aug-92	99.2	ND *	ND	ND	Pos	HSV
10/28/92	S	Aug-92	99.5	Beta Gp A	ND	ND	Pos	HSV
11/4/92	P	Oct-92	96.7	ND *	ND	ND	Pos	HSV
3/11/93	S	Dec-92	101.6	ND *	neg	neg	Pos	HSV
3/25/93	P	Oct-92	99.9	ND *	neg	neg	Pos	HSV
3/15/93	S	Dec-92	101.1	ND *	neg	neg	Pos	HSV
Date	Stat	Vacc	Temp	Culture				Result
				Strep	C. Pneu	M. Pneu	Viral	
3/9/93	S	Oct-92	97	ND *	neg	neg	Pos	Para 3
3/15/93	S	Dec-92	101.1	ND *	neg	neg	Pos	Para 3
Date	Stat	Vacc	Temp	Culture				Result
				Strep	C. Pneu	M. Pneu	Viral	
10/15/92	P	Oct-92	98.2	ND *	ND	ND	Pos	Rhinovirus
11/2/92	P	Oct-92	98.1	ND *	ND	ND	Pos	Rhinovirus
11/19/92	P	Oct-92	98.7	ND *	ND	ND	Pos	Rhinovirus
1/29/93	S	Dec-92	98.7	ND *	neg	neg	pos	Rhinovirus
Date	Stat	Vacc	Temp	Culture				Viral Result
				Strep	C. Pneu	M. Pneu	Viral	
3/8/93	P	Oct-92	99.1	ND *	Pos	neg	neg	
3/16/93	P	Oct-92	99.9	ND *	Pos	neg	neg	
4/5/93	P	Oct-92	99.8	ND *	Pos	neg	neg	
Date	Stat	Vacc	Temp	Culture				Result
				Strep	C. Pneu	M. Pneu	Viral	
10/28/92	S	Aug-92	99.5	+	ND	ND	neg	Beta Gp A
12/10/92	S	Oct-92	99.8	+	ND	ND	neg	Beta Gp A
12/14/92	S	Oct-92	98	+	ND	ND	neg	Beta Gp A
12/29/92	P	Oct-92	98.6	+	ND	ND	neg	Beta Gp A
1/7/93	P	Oct-92	99.4	+	ND	ND	neg	Beta Gp A
3/9/93	P	Oct-92	102.2	+	neg	neg	neg	Beta Gp A

\*Not Done (ND)

Table 20

Distribution of post season HI titers\* of 10 students at Lowry AFB who recieved vaccine containing 15 mcg. each of A/Beijing/353/89, A/Texas/36/91, and B/Panama/45/90 in the fall of 1992

A/Beijing/353/89 TITER											GMT
	<8	8	16	32	64	128	256	512	1024		
	100	100	100	100	90	60	30	20	10		
CUM %											137
A/Beijing/32/92 TITER											32
	<8	8	16	32	64	128	256	512	1024		
	100	70	40	30	30	10	10	10	10		
CUM %											
A/Texas/36/91 TITER											119
	<8	8	16	32	64	128	256	512	1024		
	100	100	90	70	40	40	30	30	20		
CUM %											
B/Panama/45/90 TITER											49
	<8	8	16	32	64	128	256	512	1024		
	100	100	80	50	30	10	10	0	0		
CUM %											

\* post season blood drawn April 1993

Table 21

Distribution of post season HI titers\* of 20 Permanent Party at Lowry AFB who recieved vaccine containing 15 mcg. each of A/Beijing/353/89, A/Texas/36/91, and B/Panama/45/90 in the fall of 1992

A/Beijing/353/89 TITER											GMT
	<8	8	16	32	64	128	256	512	1024		
CUM %	100	100	100	100	85	50	15	5	0		93
A/Beijing/32/92 TITER											15
	<8	8	16	32	64	128	256	512	1024		
CUM %	70	50	35	20	10	5	0	0			
A/Texas/36/91 TITER											128
	<8	8	16	32	64	128	256	512	1024		
CUM %	90	90	85	85	70	45	20	15			
B/Panama/45/90 TITER											18
	<8	8	16	32	64	128	256	512	1024		
CUM%	80	80	35	15	5	0	0	0	0		

\* post season blood drawn April 1993

Table 22

H.I. titers of 48 Students at Lowry AFB before and after receiving influenza vaccine containing 15ug each of A/Beijing/32/92 (H3N2), A/Texas/36/91 (H1N1), and B/Panama/45/90. These people were bled on 10/8/93 and 10/29/93 and were between the ages of 18 and 25 years. \*

## A/Beijing/32/92

										% $\geq$ 4X	
										GMT	rises
TITER	<8	8	16	32	64	128	256	512	1024		
CUM % PRE	100	100	98	96	75	50	23	6	4	92	
POST	100	100	100	100	98	90	65	42	23	287	46

## A/Denver/1/93 (H3N2)

TITER	<8	8	16	32	64	128	256	512	1024		
CUM % PRE	100	94	90	69	44	13	7	0	0	35	
POST	100	100	100	90	79	54	23	13	4	99	42

## A/Texas/36/91(H1N1)

TITER	<8	8	16	32	64	128	256	512	1024		
CUM % PRE	100	100	100	98	96	88	71	40	15	79	
POST	100	100	100	100	100	96	83	46	21	106	8

## A/Taiwan/1/86 (H1N1)

TITER	<8	8	16	32	64	128	256	512	1024		
CUM% PRE	100	100	100	96	94	73	54	25	6	178	
POST	100	100	100	100	100	85	56	27	10	221	8

## B/Panama/45/90

TITER	<8	8	16	32	64	128	256	512	1024		
CUM% PRE	100	98	98	85	71	48	25	6	0	79	
POST	100	100	100	96	79	63	27	8	0	106	10

\* All of these students received influenza vaccine in Feb-July 1993, on induction into the Air Force

Table 23

H.I. titers of Permanent Party \* at Lowry AFB before and after receiving influenza vaccine containing 15ug each of A/Beijing/32/92 (H3N2), A/Texas/36/91 (H1N1), and B/Panama/45/90. These people were bled on 10/8/93 and 10/29/93 and were between the ages of 20 and 55 years.

A/Beijing/32/92											
	TITER	<8	8	16	32	64	128	256	512	1024	GMT
CUM %	PRE	100	74	32	26	21	11	0	0	0	12
	POST	100	100	92	88	72	52	16	8	0	78
A/Denver/1/93 (H3N2)											
	TITER	<8	8	16	32	64	128	256	512	1024	
CUM %	PRE	100	79	32	16	5	0	0	0	0	10
	POST	100	96	84	56	28	16	4	0	0	29
A/Texas/36/91(H1N1)											
	TITER	<8	8	16	32	64	128	256	512	1024	
CUM %	PRE	100	89	74	63	42	21	5	0	0	31
	POST	100	100	100	100	84	44	24	12	4	51
A/Taiwan/1/86 (H1N1)											
CUM%	TITER	<8	8	16	32	64	128	256	512	1024	
	PRE	100	58	37	26	11	0	0	0	0	10
	POST	100	72	56	32	20	4	0	0	0	14
B/Panama/45/90											
CUM%	TITER	<8	8	16	32	64	128	256	512	1024	
	PRE	100	53	37	16	11	0	0	0	0	9
	POST	100	80	64	36	8	0	0	0	0	15

\* Paired sera were obtained from 11 individuals. Additional pre-vaccine sera were obtained from 8 persons, and post-vaccine sera from 14 persons. There were 19 pre-vaccine sera, and 25 post vaccine sera; therefore,  $\geq 4X$  titer rises were not calculated.

Table 24

## Weekly Clinic Visits with Upper Respiratory Infections, Lowry AFB,

Date	Clinic Total	URI w/o Temp	URI with Temp		
			99.6/above	Student	Perm Party
4-Oct	*	*	6	3	3
11-Oct					
18-Oct			1	0	1
25-Oct			1	0	1
1-Nov			3	2	1
8-Nov			3	1	2
15-Nov			2	1	1
22-Nov			2	0	2
29-Nov			5	2	3
6-Dec			2	1	1
13-Dec			5	1	4
20-Dec			0	0	0
27-Dec			3	0	3
3-Jan			10	2	8
10-Jan			2	0	2
17-Jan			0	0	0
24-Jan			3	0	3
31-Jan			1	0	1
7-Feb			2	1	1
14-Feb			0	0	0
21-Feb			1	0	1
28-Feb			1	0	1
7-Mar			1	0	1
14-Mar			1	0	1
21-Mar			2	0	2
28-Mar			0	0	0
4-Apr			0	0	0
11-Apr			0	0	0
18-Apr			2	0	2
25-Apr			0	0	0
total			59	14	45

\* information not available

Table 25

## Respiratory Pathogens Isolated at Lowry AFB, 1993-94

Date	Stat	Vacc	Temp	Culture				Viral	Result
				Strep	C. Pneu	M. Pneu			
3/10/94	S	Oct-93	99.8	ND*	neg	neg		Pos	Adenovirus
11/29/93	P	Oct-93	98.2	ND*	neg	neg		Pos	Flu A
11/30/93	P	Oct-93	99	ND*	neg	neg		Pos	Flu A
12/29/93	P	Oct-93	102	ND*	neg	neg		Pos	Flu A
12/30/93	P	Jan-93	99.8	ND*	neg	neg		Pos	Flu A
1/3/94	P	Oct-93	100.5	ND*	neg	neg		Pos	Flu A
1/5/94	P	Oct-93	100	ND*	neg	neg		Pos	Flu A
1/5/94	P	NV	101.7	ND*	neg	neg		Pos	Flu A
1/6/94	P	MV	99.5	ND*	neg	neg		Pos	Flu A
1/18/94	P	Jan-93	99.9	ND*	neg	neg		Pos	Flu A
1/24/94	P	Oct-93	101	ND*	neg	*		Pos	Flu A
11/30/93	S	Oct-93	100.2	ND*	neg	*		Pos	Herpes Simplex
10/18/93	S	Jun-93	100.5	ND*	neg	neg		Pos	Para 4
11/10/93	S	Oct-93	97.5	ND*	neg	neg		Pos	Para 1
12/10/93	P	Oct-93	100.7	ND*	neg	neg		Pos	Para 4
1/14/94	P	NV	99.6	ND*	neg	neg		Pos	Para 4
3/11/94	P	Oct-93	99.2	ND*	neg	Pos		neg	M. pneumoniae

\*Not Done (ND)



Table 26

## Number of Confirmed cases of influenza at Lowry Air Force Base, 1982-1994

Year	A H3N2		A H1N1		B	
	Student	PP	Student	PP	Student	PP
1982-83	1 (0)*	8 (0)	14(0)	6 (0)	0	11 (2)
1983-84	0	0	12 (0)	20 (0)	14 (0)	56 (13)
1984-85	4 (0)	32 (9)	0	0	0	2 (0)
1985-86	2 (0)	14 (2)	0	0	48 (1)	78 (9)
1986-87	0	0	23 (0)	98 (15)	0	0
1987-88	0	10 (0)	0	0	0	3 (0)
1988-89	0	1 (0)	6	33 (5)	6 (0)	16 (4)
1989-90	8 (4)	29 (5)	0	0	0	0
1990-91	0	1 (0)	0	0	4 (0)	17 (1)
1991-92	0	16 (2)	0	0	0	3 (1)
1992-93	1 (1)	15 (2)	0	0	1	6 (1)
1993-94	0	13 (0)	0	0	0	0

\* ( ) number in parentheses indicates the number who did not receive vaccine